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ANIMAL INTELLIGENCE

Animal Intelligence. By George J. Romanes, M.A., LL.D., F.R.S., Zoological Secretary to the Linnean Society. International Scientific Series. (London: Kegan Paul, Trench, and Co., 1882.)

THE psychology of animals having hitherto been treated only in detached portions, and for the most part in an uncritical manner, Dr. Romanes has "thought it desirable that there should be something resembling a text-book of the facts of comparative psychology, to which men of science, and also metaphysicians, may turn whenever they may have occasion to acquaint themselves with the particular level of intelligence to which this or that species of animals attains." But this is only one of the objects with which he has undertaken the treatment of the psychology of animals. The second and more important object "is that of considering the facts of animal intelligence in their relation to the theory of Descent." The present volume supplies the basis for this mode of considering the facts. "While complete in itself as a statement of the facts of Comparative Psychology," it is preliminary to a second division of the work, which is to be brought out as a separate treatise under the title of "Mental Evolution."

Since the present volume is to be regarded as the first part of a scientific treatise, it is, of course, important that we should know the critical principles on which the facts have been selected. Dr. Romanes has stated these in his preface. It will not be denied that his canons of criticism are sufficiently severe; and in the book itself we do not receive that impression that the facts are being described without careful discrimination, which often makes itself felt in reading collections of anecdotes about animals. But, considering the possibilities of the subject, most readers will look for descriptions which may be scientifically accurate or not, but which, in either case, are interesting in themselves. And, notwithstanding the intention he has expressed, "as far as the nature and circumstances of the inquiry would permit, to suppress anecdote," Dr. Romanes has written a book that is very pleasant to read. Besides this, the materials are arranged in such a way that there is no difficulty in finding any fact that it is desired to refer to

Dr. Romanes points out more than once "how slightly a psychological classification of animals depends upon zoological affinity, or even morphological organisation" (p. 241). The zoological classification is followed for the sake of its convenience, but at the same time it has, of course, been found necessary to treat some groups in much more detail than others. "Anatomically, an ant or a bee does not require more consideration than a beetle or a fly; but psychologically there is need for as great a difference of treatment as there is in the not very dissimilar case of a monkey and a man" (Preface, x.). As an example of the mode of classifying the facts relating to each group, the chapter on Ants may be referred to. First the researches are described that have been made in order to determine the exact character of the special senses of ants, and of the "sense of direction." After this, the powers of memory and recognition are considered, then the emotions. Then follow sections on the powers of communication, the habits, and the general intelligence of ants. Lastly, there is a short section on the nervous system and the sense organs; but this is not represented in the chapters dealing with other animals.

Though the complete theoretical treatment of mental phenomena in animals does not belong to the present volume, yet there is in the Introduction some discussion of theoretical questions. This was indeed necessary in order to arrive at a provisional mode of grouping the facts. For it has been objected to those who speak of the "emotions" of an ant or a bee, for example, that we are not justified in applying terms derived from human psychology to animals so remote in structure from the human type. Dr. Romanes replies to this objection by showing that the ground of all inferences as to the mental processes of animals is an argument from the analogy of their actions with our own. "Now it is, of course, perfectly true that the less the resemblance the less is the value of any analogy built upon the resemblance, and therefore that the inference of an ant or a bee feeling sympathy or rage is not so valid as the similar inference in the case of a dog or a monkey. Still it *is* an inference, and, so far as it goes, a valid one—being, in fact, the only inference available. That is to say, if we observe an ant or a bee apparently exhibiting sympathy or rage, we must either conclude that some psychological state resembling that of sympathy or rage is present, or else refuse to think about the subject at all; from the observable facts there is no other inference open" (p. 9).

Assuming that we are justified in concluding that the mental processes are similar when there are similar external appearances, we still need a criterion of mental as distinguished from reflex action; for we find both in men and animals examples of actions that are "mind-like and yet not truly mental." "Objectively considered, the only distinction between adaptive movements due to reflex action and adaptive movements due to mental perception, consists in the former depending on inherited mechanisms within the nervous system being so constructed as to effect *particular* adaptive movements in response to *particular* stimulations, while the latter are independent of any such inherited adjustment of special mechanisms to the exigencies of special circumstances" (p. 3). The criterion proposed is therefore—"Does the organism learn to make new adjustments, or to modify old ones, in accordance with the results of its own individual experience?" If it does, we have evidence that the limit of non-mental action has been passed; that is, we are able to fix, by means of this criterion, "the upper limit of non-mental action." After distinguishing reflex from mental action, it remains to distinguish "instinct" from "reason." Dr. Romanes proposes to define instinct as "reflex action into which there is imported the element of consciousness," and "reason or intelligence" as "the faculty which is concerned in the intentional adaptation of means to ends" (p. 17).

Dr. Romanes in his Introduction defends these last definitions against several objections, but the strongest argument that can be brought against them is found in the actual treatment of the phenomena of instinct and "general intelligence" in the chapters that follow. In discussing, for example, the question of the general intelligence of ants, Dr. Romanes speaks of "the difficulty of drawing the line between purposeless instinct and purposive intelligence." He then goes on to say, "It will be remembered that our test of instinctive as distinguished from truly intelligent action is simply whether all individuals of a species perform similar adaptive movements under the stimulus supplied by similar and habitual circumstances, or whether they manifest individual and peculiar adaptive movements to meet the exigencies of novel and peculiar circumstances" (p. 123). Now this distinction between instinct and reason, when it comes to be applied, does not seem to be essentially different from the distinction between mental and reflex action. The distinction of instinct as having an element of consciousness from mere reflex action which is unconscious, seems to vanish in the actual treatment of the subject; and the way of answering the question as to instinct that suggests itself most strongly is to define it with Mr. Spencer as "compound reflex action," placing both instinct and reflex action, as merely mechanical processes, in opposition to all conscious action.

If we take this view, we must regard all animals from the lowest to the highest as having a certain measure of "general intelligence." In the higher animals this general intelligence may be as highly developed as the mechanical processes described by the term instinct. For example, Dr. Romanes says, in speaking of the beaver, "It is really impossible by the closest study of the psychology of this animal to distinguish the web of instinct from the woof of intelligence; the two principles seem here to have been so intimately woven together, that in the result, as expressed by certain particular actions, it cannot be determined how much we are to attribute to mechanical impulse, and how much to reasoned purpose" (p. 367). Now there seems to be an advantage here in confining the term instinct to the mechanical processes and calling all the rest "general intelligence." And Dr. Romanes, except in the Introduction, seems to have looked upon the facts in this way. But in considering the question how the terms should be defined, the difficulty no doubt presented itself that reflex action, instinct, and reason are usually thought of as an ascending series. This, however, is merely because the animals in which reflex, instinctive, and rational action respectively are most prominent, form an ascending series in the scale of intelligence. The difficulty disappears when we regard all animals as having some general intelligence; for we can arrange them in an ascending series (as Dr. Romanes proposes) according to the amount of consciousness possessed by them; contrasting all along the line "nonmental neuro-muscular adjustment" (simple or "reflex," and compound or "instinctive") with the mental life properly so called.

That all animals have some consciousness, some "general intelligence," is regarded as probable by Dr. Romanes; and perhaps the most interesting portions of the book are the early chapters in which he proves the presence of an element of consciousness in animals very low in the zoological scale. "Even the headless oyster," he quotes from an unpublished MS. of Mr. Darwin, "seems to profit by experience." And this power of profiting by experience, it must be remembered, is the test of rational as distinguished from instinctive action. But we find evidence of conscious purpose even below mollusca. Dr. Romanes records an observation made by himself on rotifers, and says that if we were to depend upon appearances alone, this one observation would be sufficient ground for attributing conscious determination to these microscopical organisms (p. 19). Then after quoting "some observations relating to the lowest of all animals and made by a competent person," he remarks that "although we may suppose that the adaptive movements described by Mr. Carter were non-mental, it still remains wonderful that these movements should be exhibited by such apparently unorganised creatures [*amœbæ*], seeing that as to the remoteness of the end attained, no less than the complex refinement of the stimulus to which their adaptive response was due, the movements in question rival the most elaborate of non-mental adjustments elsewhere performed by the most highly organised of nervous systems" (p. 22).

Now these phenomena, if they are ascribed to mind at all, certainly cannot be ascribed to instinct. And it is scarcely possible, consistently with the principles laid down by Dr. Romanes, to deny that they are mental. It therefore seems as if we must admit the presence of the intelligent and volitional element in Protozoa; and this view suggests itself more strongly when we consider the nature of the movements of these animals, and when at the same time we remember Mr. Spencer's description of instinct passing into intelligence by losing its perfectly unhesitating or "automatic" character.

In the higher (as regards morphological organisation) but less plastic animals Cœlenterata and Echinodermata, Dr. Romanes finds nothing that cannot be explained as reflex action. Taking this into account along with the facts already mentioned, we may infer that the opposition between intelligent and mechanical action which shows itself in the tendency of each to encroach on the region possessed at any particular time by the other, is present from the beginning of life; and thus the division of all that is included in mind into free intelligence and organised habit (instinctive or reflex) subordinate to it, is seen to be preferable to the division into reflex action, instinct, and reason.

The kind of opposition that must always exist between these two things when they have become distinct may be made clear by bringing together the general results of the chapter on Instinct in the "Origin of Species," and of those portions of Mr. Spencer's "Principles of Psychology" mentioned by Dr. Romanes in his preface. Mr. Darwin showed, in the chapter referred to, how the most complicated instincts may be formed out of purely reflex actions by natural selection: and Mr. Spencer had already shown in the first edition of the "Psychology" how instinctive processes pass into rational processes when they become too complex to be performed unhesitatingly; and how, on the other hand, rational processes when they are often repeated become habits, and may at length be fixed by heredity as secondary instincts. More recently Mr. Spencer has shown grounds for thinking that natural selection is most important in the early stages of evolution, while the formation of habits which at first are conscious, but at last pass into instincts, is most important in the later stages of evolution. But in any case we see here both the continuity of instinct with reflex action and the constant opposition that there is between mechanical quasi-mental action and free intelligence. On the one hand the organism tends to become excessively specialised by the development of instincts under the influence of natural selection and by the formation of habits ; on the other hand rational processes are constantly being applied to slightly different material, thus becoming more varied, and instincts when they become too complex are partially disorganised and contribute their share to the activity of the free intelligence. Thus, starting with a lowly organised animal having the beginnings of intelligence and reflex action, that is, having the germs of the mental and quasi-mental processes of the higher animals, we observe from this point onwards both a process of development of each kind of action along its own line and a process of transformation of each kind of action into the other.

In some ancient civilised societies of men, habits which were originally special applications of reason to particular ends have encroached to such an extent on the free intelligence that almost the whole of life has become mechanical routine. If the specialising tendency can go so far in the case of men, may we not expect to find animals rather high in the zoological scale (perhaps some species of insects) in which *all* the mental activity has passed into the form of instinctive processes? The complementary problem to that of finding evidences of intelligence in the lowest animals would be that of finding evidences of the absence of intelligence in the higher animals. In discussing ants Dr. Romanes remarks that some species do not seem to have general intelligence in proportion to the complexity of their instincts, though "other species . . . appear to be as remarkable in this respect as they are in respect of their instinctive adjustments" (p. 127). But if there is a constant struggle between instinct and intelligence, an animal in which instincts have been fixed so rapidly that all the plastic intelligence has been absorbed in forming them is quite possible, and might be found perhaps among insects. Such an organism would be a realisation of the idea of Descartes that animals are unconscious automata. T. WHITTAKER

DALTON'S "HUMAN PHYSIOLOGY"

A Treatise on Human Physiology, designed for the Use of Students and Practitioners of Medicine. By John C. Dalton, M.D., Professor of Physiology and Hygiene in the College of Physicians and Surgeons, New York. 7th Edition. (London: J. and A. Churchill, 1882.)

THE seventh edition of this excellent work shows on almost every page that the author has submitted the previous edition to careful revision, with the result of producing a much better book in every respect. Statements are made more concisely and to the point ; irrelevant or useless illustrations are suppressed ; redundant sentences have been clipped and pruned till they express their meaning in the shortest form. Further, the arrangement of the book has been much improved. In the 6th edition, Dr. Dalton discussed the subject under the heads of "Nutrition," "The Nervous System," and "Reproduction," whilst in the present edition he has subdivided the first section into "Physiological Chemistry" and "Nutrition," properly so called. This arrangement has enabled him to describe more fully the chemical composition of proximate principles and to arrange the facts in a more natural order. As a matter of logical arrangement, it is doubtful how far Dr. Dalton is justified in treating of the Bile under "Digestion," and the Glycogenic Function of the Liver under "Absorption," but no doubt he has felt the difficulty experienced by those who have been obliged to deliver a systematic course of lectures on physiology as to the natural position of those important functions. At what point do they come in, if it be the object of the teacher to describe facts in natural sequence and in such a way as to help the student in grasping an idea of the entire mechanism? In the digestive process, the bile plays a comparatively unimportant part whilst the production of glycogen by the liver has little to do with absorption. Still both of these processes have a natural relation to the great functions under which Dr. Dalton has placed them, and an author may be excused for arranging them as he has done, on the ground that it is impossible for any one, with our present views of nutrition, to state precisely under what head, in any systematic treatise, these functions should be described.

In discussing the "Nervous System," Dr. Dalton has judiciously incorporated the facts brought to light by recent investigators. Thus we have a careful description of the physiological anatomy of the cerebral hemispheres and associated ganglia, and an account of the experimental evidence supplied by Fritsch and Hitzig, Ferrier, Schiff, Hermann, and Carville and Duret. In particular, prominence is given to the attempts of Ferrier and others to determine special centres for sensory perceptions, and to what may be called the "check" experiments of the New York Society of Neurology and Electrotology. Less importance is justly given to the results reached by the rough method of extirpation followed by Flourens and many others. Not a few still doubt the view that there are portions of the cerebral convolutions devoted to special motor or sensory functions, but the student will find in Dr. Dalton's pages a very clear exposition of the results of modern investigation.

The chapter on the "Senses" is clear and intelligible so far as it goes. It does not pretend to give an account of the almost innumerable phenomena of the senses, but it gives a fair representation of the more common phenomena, whilst it is suggestive and critical. The account of the mechanism of accommodation is meagre and might be much improved. No account is given of any theory of colour-perception. The account of the auditory mechanism is excellent, and the author is extremely careful in discussing the attempts made to explain the organ of Corti.

The special feature of this book, in all editions, is the prominence given to the function of *reproduction*, and we may add that no text-book of a general character gives so full and explicit an account of this department. Here, as elsewhere, the author has endeavoured to be a teacher, and has aimed not so much at giving a detailed account of all the steps of the process as at presenting the subject in a form easy of comprehension. Thus whilst it might be possible to point out statements slightly erroneous or